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Concept of modernization of input device of oil and gas separator

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Abstract. The process of defoaming in oil production is discussed. This technology is important in oil and gas fields. Today, the technology of separating the gas fraction is based on chemical catalysis. The use of mechanical technologies improves the economics of the process. Modernization of the separator input device is based on the use of long thin tubes. The chosen length of the tubes is two orders of magnitude larger than the diameter. The separation problem is solved by creating a high centrifugal acceleration. The tubes of the input device are connected in parallel and divide the input stream into several arms. The separated fluid flows are directed tangentially into the working tubes to create a vortex motion. The number of tubes connected in parallel is calculated in accordance with the flow rate of the fluid. The connection of the working tubes to the supply line is made in the form of a flange. This connection allows carrying out maintenance without stopping the flow of fluid. An important feature of this device is its high potential for further modernization. It is concerned with the determination of the parameters of the tubes and the connection geometry in the construction of a single product.

1. Introduction

The production of oil wells is a complex heterogeneous system. It is a mixture of liquid hydrocarbons (oil or condensate), water and gases. In addition, to saturate with water vapor and heavy hydrocarbons, solid rock particles and other components are present.

In this regard, the necessary condition for oil supply to the oil pipeline is the removal of water, gases and solid phase, directly in the oil field. The process of separating well production into the liquid and gas phases is called oil separation. Separation occurs mainly as a result of the action of natural phenomena (forces of gravity, inertia, etc.). Vapors of water and heavy hydrocarbons are extracted from the gas by sorption or cooling. Separators used for the separation of oil and petroleum gas are called oil and gas separators. [4]

A gas-liquid mixture with relatively low gas content is treated in gas and oil separators. The separation of oil and gas in the separator is mainly due to the use of gravity and partial settling of products. Typically, various input devices are provided in the separator design. In this case, forces of inertia and adhesion are added to the gravity.

In the oil-fields practice, different separation technological systems are used to separate well products. The choice of the separation system depends on the rheological, physical properties of the fluid, as well as on the processes of dispersion and coalescence. These parameters are determined by the production conditions, the technology of collecting and transporting the fluid to the separation



point. Moreover, these conditions are constantly changing at all stages of development of the oil field. [5]

Directly the systems of the gas-liquid mixture entering the separators are significantly affected to the effectiveness of separation. The flow distribution between the separators has also an influence. In the oil and gas separator, the dispersion structure and concentration of liquid droplets in the flow and foaming depend on the input structure. Finally, this is the quantitative drift of the discrete phase from the apparatus. [4]

2. The modernization of the oil and gas separator.

One of the main parameters of the separators is their productivity. There are several main factors that determine the effectiveness of the separation process, and its productivity. Among them, there is stabilization of oil, foaming and degassing of the gas-liquid mixture.

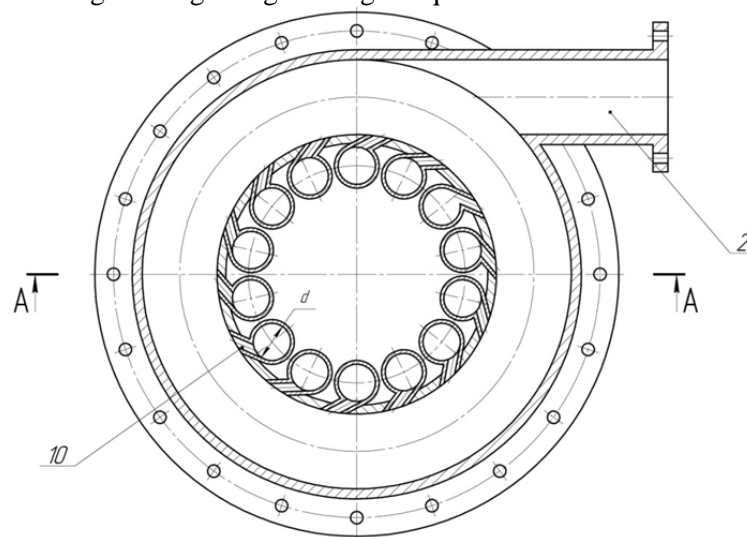


Figure 1. Input device, top view

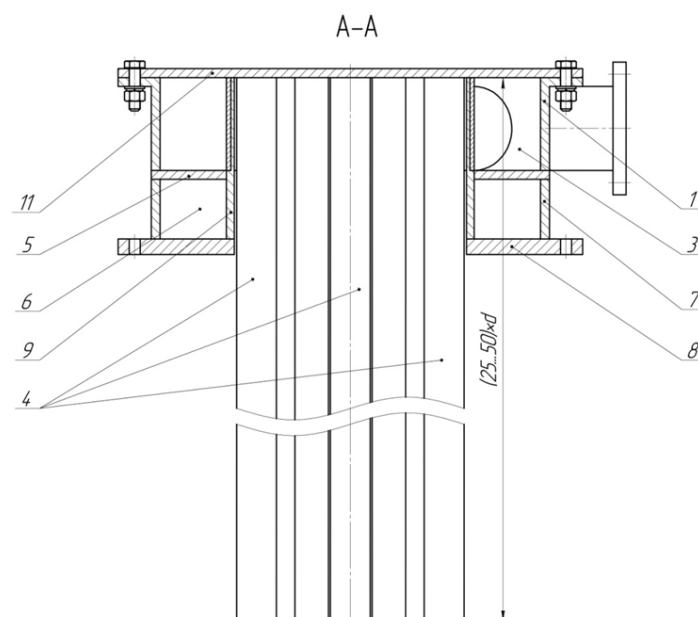


Figure 2. Input device, side view

Insufficient stabilization of oil, as well as increased foaming at the inlet of the separator, lead to an increased content of dropping oil in the exhaust gas. And besides, a large amount of dissolved gas is stored in the oil at the outlet of the separator. This point has a simple explanation. Namely, the appearance of a layer of foam at the oil-gas boundary hampers the process of oil degassing. At a certain thickness of the foam layer, the kinetic energy of the gas bubbles is not sufficient to overcome the mechanical strength of the oil films. Obstruction is formed by structured oil films forming a foam skeleton. The useful volume of the separator, as well as its performance reduces effectively.

The authors propose to modernize the input device of the oil and gas separator. The device is intended for use in oil and gas separators at oil producing enterprises. The input device is shown in Fig. 1 and Fig. 2. It consists of a cylindrical body 1 with a nozzle 2 tangentially welded into it and an inner closed chamber 3. The chamber 3 has a rectangular section and serves to distribute the flow along the entire set of vortex tubes. The dividing annular partition 5 is welded to the bottom of the distribution chamber. The partition 5 divides the air chamber 6 and the distribution chamber 3. The air chamber 6 is a closed circuit and consists of a steel cylindrical casing 7 and a welded flange 8. The flange 8 serves for securing through the hatch vessel. Inside, the inlet is a cylinder 9 welded to the lower flange. Along the entire circumference of the cylinder 9 there are oblique slots 10. Slots 10 are intended for joining the inputs of the vortex tubes 4. The tubes have a tangential inlet and are located along the entire perimeter of the cylinder. The number of tubes is selected according to the technical conditions of the separator operation: pressure, capacity, etc. A lid 11 is fastened to the body by means of a bolted connection. The prevention of fluid outflow is realized by the presence of sealing elements. Places of contact between the surfaces of the body and the lid, lids and tubes are sealed. The choice of sealing elements creates the prerequisites for the further development of the design and the proposed concept as a whole.

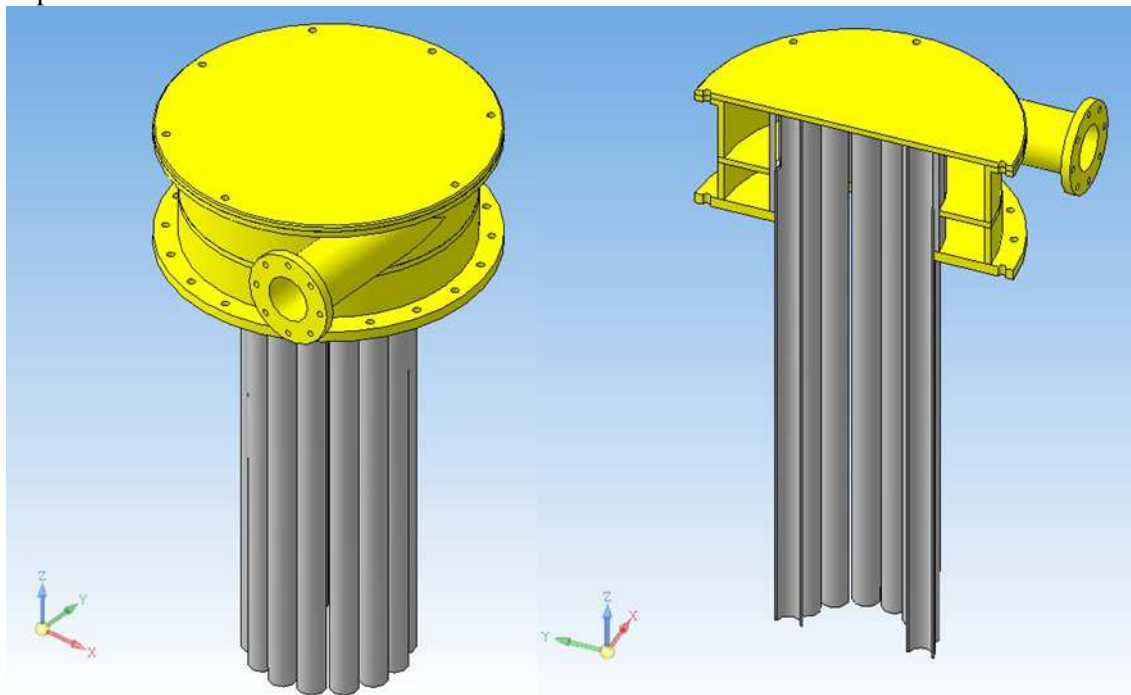


Figure 3. Input device to separator

The device works as follows. The oil emulsion is fed through the nozzle 2 to the flow distribution chamber 3. The circulation of the fluid under pressure in a closed loop is formed in the chamber 3. The emulsion through the slits 10 falls tangentially into the vortex tubes 4. The liquid is deflected to the wall of the tube by centrifugal forces. On the walls of the tubes a film is formed, which subsequently drains into the lower part of the separator. In thin tubes of inch diameter, large values of centrifugal

force arise. Along the tube radius, conditions are created for efficient separation of liquid and gas [3]. There is a coalescence of gas bubbles and drops of water from the oil.

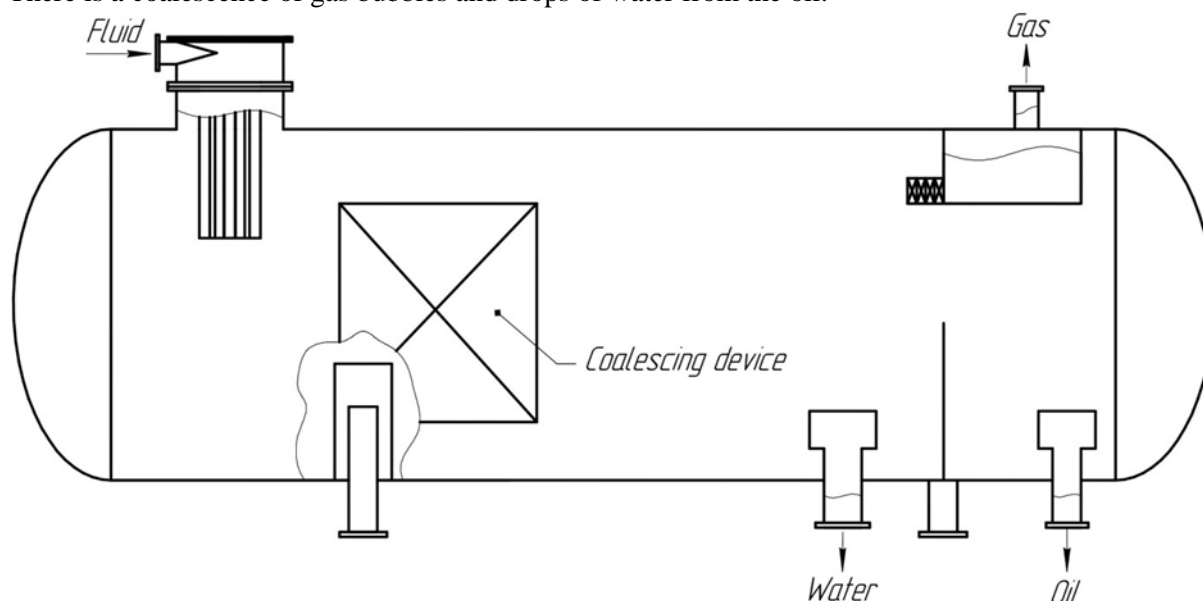


Figure 4. General view of separator

The advantage of this device (Figure 4) is the simplicity of manufacturing, taking into account conditions of the operating mining enterprise. The device is removable and mounted on the hatch with bolted connection, which greatly simplifies the possibility of installation, repair and maintenance of process equipment. The installation diagram is shown in Figure 4.

3. Conclusion.

The main advantage of the device lies in the fact that a significant portion of the oil gas is removed from the liquid phase when the oil emulsion is initially supplied. This makes it possible to substantially prevent the formation of foam as the fluid pressure changes. Economically, this is a reduction in the costs of defoamers and chemical reagents. It seems possible to simplify the device separator, as an example, to reduce the set of internal separator devices. This is especially true for oil with large water cut and gas factor.

Thus, the technical result of the proposed modernization concept is to increase the efficiency of the oil emulsion separation process in three-phase separators. As a result of this input device, the efficiency of the preliminary separation of the gas and liquid phases is enhanced. The effect is achieved due to the large values of the centrifugal force, and, accordingly, the separation factor.

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